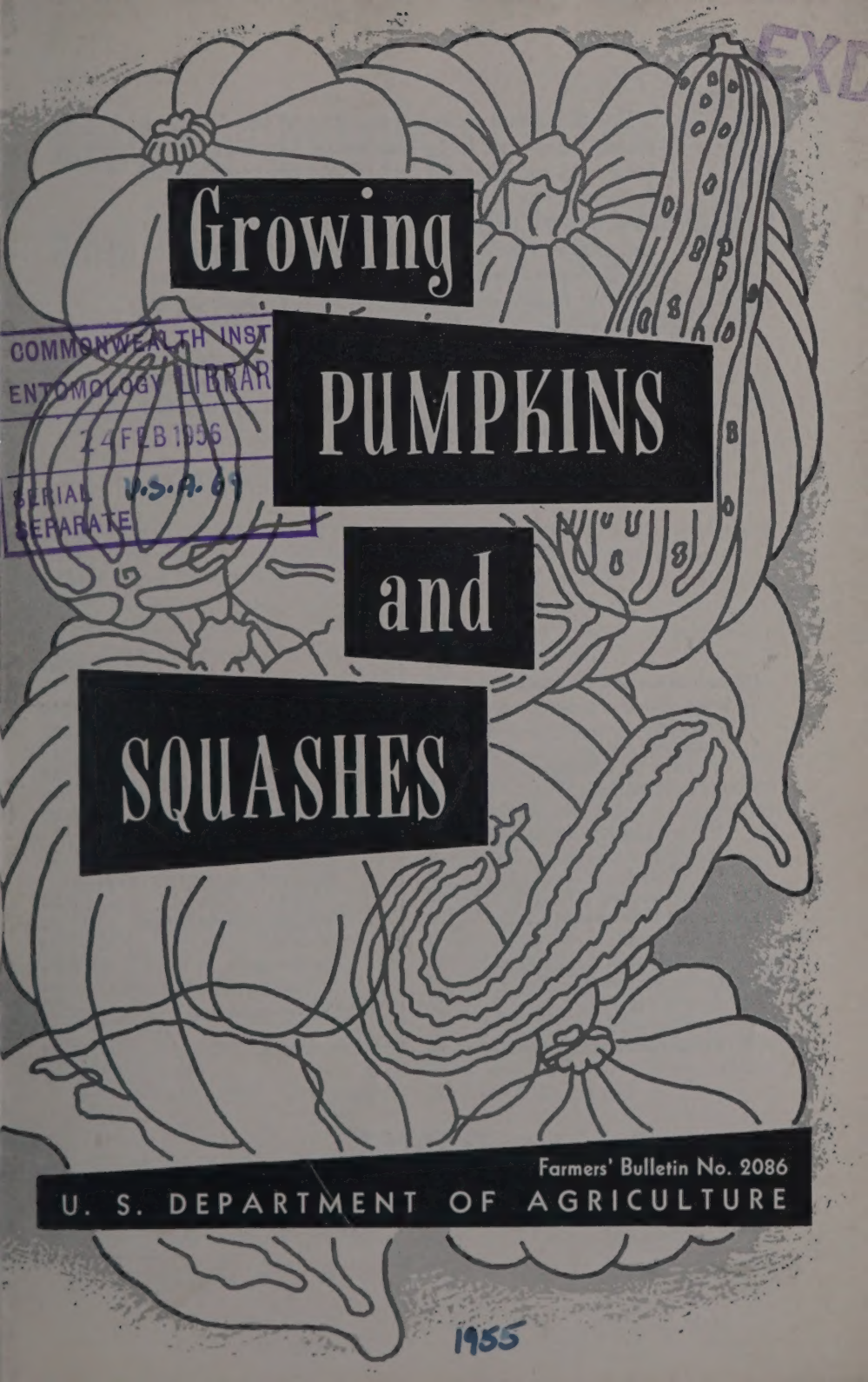

Growing PUMPKINS and SQUASHES

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Pumpkins and squashes are among the few food plants considered to be natives of America. They are known to have been used by the North American Indians before the advent of the European settlers. Both are nutritious and valuable vegetable crops and have many and varied uses. If properly handled and stored, a supply may be had from midsummer to late spring. In addition to their use as fresh vegetables, a large tonnage of pumpkins and squashes is canned each year; the canned product is used largely for pie making. In acreage and crop value the pumpkins and squashes are among the less important vegetable crops.

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Growing PUMPKINS and SQUASHES

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CLIMATIC AND SOIL REQUIREMENTS

Pumpkins and squashes can be grown for local use in all parts of the United States, but their large-scale commercial production is limited to those States where the growing conditions are most favorable. The States having the largest acreage devoted to the production of pumpkins are Illinois, New Jersey, California, Indiana, New York, Ohio, Michigan, Pennsylvania, Iowa, Colorado, Delaware, and Texas. The States growing the largest acreage of squashes are Florida, California, Texas, New York, Georgia, New Jersey, Massachusetts, Michigan, South Carolina, North Carolina, Maine, and Oregon. The relative position of the States may vary from year to year because of season and market conditions.

Almost any good, well-drained garden soil will grow pumpkins and squashes; these crops will not tolerate a wet, poorly ventilated soil. The soil should be well supplied with organic matter and be retentive of soil moisture; a soil capable of retaining its moisture is especially desirable in localities where rainfall is likely to be deficient.

A soil of medium texture is best, but good yields can be produced on the heavier and lighter soils if they are properly handled and well fertilized. A light rich soil that warms up rapidly is desirable for growing summer varieties for the early market.

Pumpkins and squashes do best on soils that are slightly acid or nearly neutral; good yields are produced on some of the slightly alkaline soils of the West. Avoid extremely acid soils.

VARIETIES

The pumpkins and squashes belong to three species of the genus *Cucurbita—Cucurbita pepo, C. moschata,* and *C. maxima.* Most of the common varieties of pumpkins are *C. pepo,* but a few varieties

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such as Large Cheese and the Cushaws belong to *C. moschata*. The winter squashes are mostly *C. maxima*. There is no well-defined way of telling which varieties are pumpkins and which are squashes. The separation of pumpkins from squashes is largely a matter of popular usage. The species characteristics have not been followed in distinguishing pumpkins and squashes. While most varieties of *C. maxima* are called squashes and most of the varieties of *C. moschata* are called pumpkins, some of the varieties of *C. maxima* are called pumpkins and some varieties of *C. moschata* are called squashes. Many varieties of *C. pepo* are called pumpkins and many others squashes. Some botanists distinguish a fourth species, *C. mixta*, more or less intermediate between *C. maxima* and *C. moschata*. Cushaws, certain other winter squashes, and pumpkins are considered by those botanists as belonging to the species *C. mixta*.

All the varieties of *Cucurbita* that are eaten in the immature stages, such as the Crooknecks, Bush Scallops, and Cocozelles, are classed as squashes, as are most of the hard-rind ones that are suitable for winter storage, such as the Hubbards.

The squash varieties are divided into 2 groups: (1) Those that are eaten in the immature stages while the rind is very soft are classed as summer squashes; (2) those that are eaten only after the fruits are mature are classed as winter squashes.

The difference in hardness of the rind at full maturity is one of the distinguishing differences between most varieties of pumpkins and squashes. The rind of most of the pumpkins is not very hard even at full maturity, while the rind of most winter squashes is quite hard at full maturity.

Under favorable conditions most of the summer varieties of squash produce the first usable fruits in 7 to 8 weeks from planting and will continue to bear for several weeks. The winter varieties of squash and the pumpkins require 3 to 4 months to mature a crop, and a single planting is normally harvested all at one time instead of successively like the summer squashes.

SQUASHES

The most widely grown of the summer squashes are the Crookneck and Scallop types. There are several varieties and strains of each. The Yellow Summer Crookneck is one of the most popular. The Straightneck type, which is very similar to the Crookneck except in shape of the neck, is becoming popular because the straight-necked fruits are more easily handled in packing for shipment. One of the best of these is Prolific Straightneck (fig. 1). Of the Scallop type there are white, yellow, and striped-skinned varieties. The white ones are the most popular; Early White Bush is the leading variety. The Vegetable Marrows are a group that includes both bush and vining

Figure 1.—A mature fruit of Prolific Straightneck squash.

forms. Long White is one of the best of the bush form. The English Vegetable Marrow is a good strain of the vining form.

The Cocozelle and Zucchini, bush summer squashes of the vegetable marrow type introduced from Italy, are grown extensively for the early market. The Zucchini is a relatively new variety, having first been offered for sale in California in 1921. It has rapidly become popular. A dark-skinned strain has recently been introduced. Caserta, a recently introduced variety of the Cocozelle type, is an early prolific variety that has met with general market favor.

Among the best of the late winter squashes are the Boston Marrow, Delicious, Marblehead, Buttercup, Butternut, Table Queen, and varieties of the Hubbard type. The Boston Marrow should not be confused with the Vegetable Marrows already mentioned. There are several varieties of the Hubbard type, including Golden Hubbard, Blue Hubbard, Warted Hubbard, and Green Hubbard. The blue and the warted produce the largest fruits, weighing from 12 to 18 pounds. The various Hubbards differ chiefly in size, color, and time of maturity. The Green Hubbard (fig. 2) is probably the most popular of the dark-skinned Hubbard group.

Figure 2.—Green Hubbard squash.

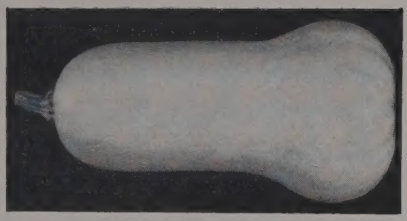

Figure 3.—A mature fruit of Butternut squash.

The Golden Hubbard, the earliest of the Hubbards, has a rich, orange-colored skin. The Hubbards are among the best of the squashes for winter storage. The Delicious is regarded by many as the finest of all squashes in quality. The fruits are top-shaped, tapering to the blossom end. There are both green and golden varieties of Delicious type. Boston Marrow is somewhat similar to Delicious. Two squashes of comparatively recent origin, Buttercup and Butternut (fig. 3), are varieties of very high quality. Table Queen or Acorn (fig. 4) is a

Figure 4.—A mature fruit of Table Queen squash.

popular winter type. It is prized for its excellent baking qualities and for its small size, which makes it convenient for cutting in two pieces and serving as individual portions. The shell is hard and slightly ridged longitudinally. The skin of the immature fruits is a very dark green but turns to an orange, yellow, or copper color in storage after full maturity. It keeps very well in storage.

The largest of the squashes, sometimes listed as a pumpkin, is Mammoth, also called Mammoth Chili and King of the Mammoths. The fruits may grow to very large size and are often found in exhibits at county fairs. The flesh is too coarse and poor in quality for general table use. It is grown chiefly for stock feed.

PUMPKINS

The best and most popular of the pumpkin varieties include Sugar, Connecticut Field (fig. 5), Cheese, and the Cushaws. Sugar is one of the smallest of the pumpkins. The flesh is very fine grained and sweet. It is a good variety for pie making. Sugar pumpkins are frequently planted in cornfields in the Northeastern States. The golden yellow fruits are seen in the fields after the cornstalks have been cut. In some localities Kentucky Field, a variety very similar to Cheese, is grown. Connecticut Field, Cheese, and Golden Cushaw are grown extensively for canning. The Cushaw type produces large, elongated, pear-shaped fruits, the necks of which are solid and free from seed cavities. The seed cavity of the Cushaws is confined to the bulbous apex. There are several strains of the Cushaw pumpkin. Among them are Golden, Green Striped, and White, which differ in color, size, and length of neck. The Green Striped is the most popular of the Cushaws.

Figure 5.—Connecticut Field pumpkin.

The large-fruited varieties such as Mammoth, Connecticut Field, Cheese, and Cushaws are among the varieties most grown for stock feed.

VARIETIES FOR CANNING

Both pumpkins and squashes are used for canning. The canned products are similar and both are used for pie making. Some of the canned product is a blend of pumpkin and squash varieties. The large-fruited and heavy-yielding varieties that have yellow or light-colored rinds and flesh of good texture are the most desirable for canning. The green-skinned varieties are more difficult to prepare for canning because all green tissue must be removed to avoid off-color in the canned product. To meet the requirements of the commercial canning trade a variety must be a heavy yielder, fruits must have

flesh of deep orange-yellow to orange color, and the flesh must be free of fiber and coarseness.

Squashes and pumpkins for canning are generally grown under contract with the canning company. The company usually supplies the seed of the variety it desires. The canner should be consulted before a large acreage of pumpkins or squashes is planted with the expectation that the canning company will handle the crop.

Among the pumpkin varieties most used for canning are Connecticut Field, Cheese or Kentucky Field, Winter Luxury, and Golden Cushaw. Of the squashes, Boston Marrow, Delicious, and Golden Hubbard are the varieties most used. Connecticut Field and Cheese are favored as canning sorts throughout the Middle West. Boston Marrow squash and Cushaw pumpkins are popular with eastern canners. Kentucky Field is a popular canning squash in the West.

MIXING OF VARIETIES

If one wishes to save seed for planting purposes or maintain a true-breeding seed stock of a squash or pumpkin variety, it must be grown alone, with considerable distance as a barrier between it and other varieties. Otherwise, the next season's crop may show mixtures with the different varieties grown near each other. In pumpkins and squashes, the male and female organs are borne in separate flowers on the same plant. They are largely insect pollinated. This flowering habit results in much intervarietal crossing where different varieties are grown close to each other.

Not all varieties of pumpkins and squashes will cross-pollinate when grown in the same field. All the varieties of a species, however, will mix or cross when grown in the same field. That is, all the varieties of *C. pepo* can cross-fertilize each other; all the varieties of *C. moschata* can cross-fertilize each other; and all those of *C. maxima* can cross-fertilize each other.

There is little probability that varieties of *C. pepo* will mix with varieties of *C. maxima*. The varieties of *C. moschata* may mix with varieties of either *C. pepo* or *C. maxima*, but this is not common.

The question is often asked whether pumpkins and squashes will mix with cucumbers, watermelons, or muskmelons. Pumpkins and squashes will not mix with any of these other vine crops.

CULTURE

SOIL PREPARATION

Like other cucurbits, squashes and pumpkins have large but shallow root systems. The root growth is very rapid and extensive in the upper 6 or 8 inches of soil. Therefore the upper layers of soil should be thoroughly prepared and well fertilized for best results.

Pumpkins and squashes respond to liberal applications of fertilizer unless the soil previously has been

heavily fertilized. Well-decomposed stable manure is best and should be applied at the rate of 6 to 10 tons or more per acre when it can be obtained at a reasonable cost. Heavy applications of manure should be broadcast and plowed under in the fall. If the manure supply is limited to a few tons per acre, it can be used most efficiently by working it into the hills before planting. Manure applied in the hills should be well decomposed and thoroughly mixed with the soil. Manure that is not well rotted, especially strong manure like horse, poultry, or sheep, should not be used where it is to be applied in the hills at planting time.

Most of the eastern soils respond to an application of complete commercial fertilizer in addition to animal manure. Superphosphate at the rate of 1,000 to 1,500 pounds per acre can be expected to return a profit, especially in the Middle West, where the soil is likely to be deficient in phosphorus. In the irrigated sections of the West, where the humus content of the soil is low, animal manure supplemented with a nitrogen fertilizer is likely to give the best results. Soils vary so greatly in their fertilizer requirements that little specific advice can be given as to the best fertilizer combination to use.

In general, 500 to 1,500 pounds of a complete fertilizer containing 4 to 6 percent nitrogen, 8 to 10 percent phosphoric acid, and 5 to 8 percent potash can be used profitably in growing pumpkins and squashes. Fertilizers having a 5–10–5 analysis are widely used and their use can generally be recommended. In light soils where nitrogen is lost rapidly 1 or 2 side dressings with nitrate of soda or ammonium sulfate at the rate of 100 to 150 pounds per acre may be profitable.

Moderately acid soils should be limed at 1,000 to 1,500 pounds of ground limestone per acre.

PLANTING

Pumpkins and squashes are warm-season crops and are sensitive to frost. Like other cucurbit crops pumpkin and squash are somewhat difficult to transplant and are seldom started under glass for transplanting to the field. Only the summer varieties can be transplanted profitably, and then only when an early market means increased profits. High prices are often obtained from an early crop of such summer squashes as the Crooknecks, Scallops, and Cocozelles. Nothing is gained from transplanting the late or main crop of pumpkins and squashes.

If squashes are to be transplanted seed is planted early in individual containers in hotbeds or other protected frames. Seedlings can then be transplanted to the field with a minimum of root disturbance. Pint or quart wooden berry baskets make good containers for growing a few hills of early squashes (fig. 6). Squash plants will not withstand transplanting if the soil is removed from the roots or if the roots are appreciably disturbed.

Planting should be delayed until the soil has warmed up and is in good condition for germination and

Figure 6.—Hill of summer squash started in a 1-quart strawberry box.

air temperatures are favorable for growth of warm-season crops. Pumpkin and squash seed may decay before germinating if planted in wet, cold soil.

The bush and small-vine varieties may be planted in hills as close as 4 by 5 feet, but the varieties having long running vines should be spaced 8 to 12 feet apart each way, the distance depending on the growth habit of the variety and the fertility of the soil.

The seed is sometimes planted in drills rather than in hills, and the seedlings are thinned to about 4 feet apart in the row. This gives each plant a better chance for development.

The amount of seed required to plant an acre varies from 2 to 4 pounds, depending on the size of the seeds and the planting distances. It is best to plant plenty of seed and to thin the plants to not more than three to a hill after danger from early attacks by insects is past. The seed should be covered to a depth of about 1 inch. It may be covered a little deeper in light soils than in heavy soils, especially in those having a tendency to form a crust on the surface.

CULTIVATION

Cultivation should be shallow to avoid injuring the shallow roots. It is doubtful whether these crops should be cultivated more than is necessary to keep down weed growth. The removal of weeds by means of sweeps that cut just under the surface is preferable to using implements that stir the soil to greater depth.

CURING AND STORING

Of the squashes, only the hard-shelled varieties are adapted for long storage. Some of the pumpkins, such as Table Queen, Large Cheese, and Small Sugar, can be kept until after Christmas if properly handled. Both squashes and pumpkins should be well matured and carefully handled in harvesting and storing. Cuts and bruises in the rind are open to decay organisms that may cause a great deal of loss from rot in a short time. Under proper conditions wounded areas on both squashes and pumpkins are capable of healing over by producing suberized tissue, which gives protection against the entrance of rot organisms. This protecting tissue seems to develop best at a relatively high temperature and in a moist atmosphere.

Good results have been obtained by curing pumpkins and squashes

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Figure 7.—Hubbard squashes stored on shelves.

with stove or other artificial heat at a temperature of 80° to 85° F., with a relative humidity of about 80 percent, for 10 days after harvesting. At the end of the 10-day period they should be put in a dry place and the temperature kept between 50° and 60°. It is essential that the surface be kept dry during the storage period. Temperatures above 60° tend to keep the respiration rate too high, and considerable loss through shrinkage results. Excessive loss of moisture impairs the quality.

Any dry place where the proper temperature can be maintained is suitable for the storage of squashes and pumpkins. They keep best when not piled on top of each other. A good method is to provide shelves where they can be spread out in a single layer with a small space between the fruits (fig. 7). Storing them in this manner greatly reduces the chances of loss from decay.

INSECTS AND THEIR CONTROL[1]

Pumpkins and squashes are attacked by many kinds of insects, the more important of which are the melon aphid, cutworms, cucum-

[1] For additional information regarding insects attacking pumpkins and squashes, communicate directly with your State agricultural college or with the Entomology Research Branch, Agricultural Research Service, Plant Industry Station, Beltsville, Md. If you do not recognize the insect causing injury, send specimens for identification, together with an explanatory letter. The specimens should be placed in a vial of preservative, such as formalin, and this should be wrapped carefully in a durable container to avoid breakage or loss in transit.

PRECAUTIONS

Most insecticides are poisons. Handle them with great care. Store them in closed containers where they cannot be mistaken for food or medicine, and where children or farm animals cannot reach them. See that the containers are properly labeled. *Follow the manufacturer's directions and warnings on the container.* Do not apply insecticides at greater strengths and dosages than recommended. Wash your hands and other exposed parts of the body after working with any insecticide.

Parathion and TEPP are extremely dangerous poisons. These insecticides should be used only by trained operators who will assume full responsibility and enforce proper precautions as prescribed by the manufacturers. A person applying them should wear a tight-fitting gas mask or respirator equipped with a canister specified for use in handling organic vapors, acid gases, and dusts. Parathion, TEPP, and toxaphene are absorbed through the skin. A person handling or applying them should wear protective clothing, keep the shirt buttoned at the neck, keep the sleeves rolled down, and bathe and wash clothing daily. Growers are cautioned not to prepare parathion or TEPP dusts but to buy them ready-mixed.

Persons applying an insecticide containing sabadilla may suffer irritation of the nasal passages and considerable sneezing. Proper use of a respirator will reduce this discomfort.

Cryolite should not be applied to pumpkin or squash when the fruits are on the plants, unless it is known that the residue will be removed by washing, brushing, peeling, or other means. Parathion should not be applied within 15 days of harvest. Malathion and lindane should not be applied within 3 days of harvest. TEPP should not be applied within 24 hours of harvest.

ber beetles, the squash bug, the squash vine borer, the pickleworm, and the melonworm.[2]

MELON APHID

The melon aphid is a small, louse-like insect, which obtains its food

[2] Names of insects mentioned follow:

COMMON NAME	SCIENTIFIC NAME
Melon aphid	*Aphis gossypii*
Black cutworm	*Agrotis ypsilon*
Granulate cutworm	*Feltia subterranea*
Variegated cutworm	*Peridroma margaritosa*
Striped cucumber beetle	*Acalymma vittata*
Western striped cucumber beetle	*Acalymma trivittata*
Banded cucumber beetle	*Diabrotica balteata*
Spotted cucumber beetle	*Diabrotica undecimpunctata howardi*
Squash bug	*Anasa tristis*
Squash vine borer	*Melittia cucurbitae*
Pickleworm	*Diaphania nitidalis*
Melonworm	*Diaphania hyalinata*

by sucking plant juices. It feeds on the underside of the leaves, and its presence often is first shown by a slight curling or cupping of leaves. An infestation may start when a few winged females fly to pumpkin or squash plants from one of the aphids' other food plants. These females start new colonies, which can spread over the entire plant and throughout the field. In heavy infestations the leaves curl and lose color, and the affected plants die. The aphids also spread such diseases as mosaic from plant to plant.

Examine pumpkin or squash plants frequently for aphids; use an insecticide before the infestation becomes widespread. The insect is hard to control; once it is established in a planting it may destroy the crop.

Control the melon aphid with sprays or dusts containing parathion, TEPP, nicotine, or malathion.

Parathion can be used either in a 1-percent dust or in a spray containing 1 pound of a 15-percent wettable powder in 100 gallons of water. A spray prepared from a parathion emulsifiable concentrate is also effective, but it may injure the plants slightly.

TEPP can be used either in a 1-percent dust or in a spray containing ½ pint of a 40-percent concentrate in 100 gallons of water. TEPP dusts and sprays soon lose their effectiveness. To prevent this loss the sprays should be applied immediately after they are prepared, and the dusts within about a week after the package is opened. Partly used bags of the dust should be kept tightly closed. TEPP is especially useful when an insecticide is needed to combat the melon aphid within the harvest season.

Malathion can be used either in a 4- or 5-percent dust or in a spray containing 4 pounds of 25-percent wettable powder or 1½ pints of 50-percent emulsifiable concentrate in 100 gallons of water. Malathion should not be applied to wet foliage.

Apply parathion, TEPP, or malathion dusts at 15 to 30 pounds per acre, and sprays at 50 to 125 gallons per acre; vary the amounts to suit the size of the plants and the degree of insect infestation. Repeat the applications weekly until the aphids are brought under control.

Nicotine should be applied only when the air temperature is 70° F. or above, when the plants are dry, and when there is little or no wind. Its effectiveness depends on the thoroughness of the application. Be sure that the dust or spray coats the undersides of the leaves. In general, nicotine has proved more effective in dusts than in sprays, especially when the foliage is dense. Sprays give satisfactory results, however, when applied at high pressure and when the nozzles are properly set.

Nicotine dust should be freshly prepared and contain 4 percent of

GUIDE FOR MAKING A NICOTINE SPRAY

	To make 50 gallons	*To make 1 gallon*
Nicotine sulfate (40 percent nicotine)	¾ pint	2 teaspoonfuls.
Soap (mild alkaline, readily dissolved form)	2 pounds	2 tablespoonfuls.
Water	50 gallons	1 gallon.

actual nicotine. Use 20 to 40 pounds per acre, depending upon the size of the plants and the number of aphids present.

To make a nicotine spray, thoroughly mix the materials shown in the guide at the bottom of page 10.

Apply the spray at the rate of 50 to 125 gallons per acre. Repeat the dust or spray application weekly until aphid control is obtained.

CUTWORMS

Cutworms are stout, soft-bodied, smooth caterpillars that hide in the soil during the day and feed at night. They sometimes are very destructive to small plants of pumpkin and squash. These pests can be controlled readily with a dust, a spray, or a bait. Since squash and pumpkin plants are susceptible to injury by toxaphene and DDT, only the bait should be used after the plants are up, and then only when the plants are dry.

Dusts.—Treat the soil surface with 10-percent toxaphene or DDT dust at the rate of 30 pounds to the acre (¾ pound to 1,000 square feet).

Sprays.—Before planting, apply to the soil surface a spray containing 5 pounds of 40-percent toxaphene or DDT wettable powder in 100 gallons of water at the rate of 100 gallons to the acre (6 level tablespoonfuls in 2 gallons of water to 1,000 square feet).

Bait.—Use the following poisoned bait: 1 peck (or 5 pounds) dry bran, ½ pound of a 40-percent toxaphene wettable powder or ¼ pound of sodium fluosilicate or paris green, and 3 quarts of water. For larger quantities use 25 pounds of dry bran and 2 pounds of the toxaphene or 1 pound of sodium fluosilicate or paris green.

To prepare this bait:

(1) Thoroughly mix the poison with the bran. This is important. Each particle of bran must carry a little poison to get a good kill. When making small quantities, mix the bait in a bucket with a paddle; add the poison slowly as you stir the bran. When making large quantities, mix the poison with the bran on some flat, smooth surface; use a shovel and rake in much the same way as in mixing concrete.

(2) Add the water to the mixture of bran and poison, stirring slowly all the time. Large quantities of water added at one time will wash the poison from the bran and give an uneven mixture. Add only enough liquid to make a crumbly mass. It is a good plan to set aside a little of the mixture of dry bran and poison so that if too much water is used this dry reserve can be added to bring the mixture up to the proper consistency. Large quantities can be made up in galvanized-iron or wooden washtubs and small quantities in buckets or similar containers.

Either broadcast the poisoned bait or sow it by hand along the rows or about the base of the plants. Do this late in the evening so that the bait will not dry out before the worms get busy. Since many kinds of cutworms overwinter in the ground and start feeding as soon as the weather becomes favorable in the spring, it is a good plan to broadcast the poisoned bait over the field before the crops are planted.

Forty pounds of the wet bait per acre (or about 1 pound to 1,000 square feet) is enough for one application. If the bait is applied directly to the rows or hills a smaller quantity is sufficient. It may require 2 or 3 applications at 2-day intervals to rid the field of the pests.

CUCUMBER BEETLES

There are several kinds of cucumber beetles, and they vary in importance in different parts of the country. The striped cucumber beetle is most abundant east of the Rocky Mountains. The spotted cucumber beetle sometimes becomes a menace to pumpkin and squash in the same areas. Both species occur in the South and Southwest, and in recent years a third species, the banded cucumber beetle, has become an important pest there; it is sometimes more numerous than the other two. The western striped cucumber beetle and the western spotted cucumber beetle cause injury in the Rocky Mountain and Pacific Coast States.

Cucumber beetles frequently attack the plants as soon as they come up; they may kill them. As the plants grow, the beetles feed upon the leaves, flowers, tender shoots, and fruits. The stalks may be girdled near the soil surface. These insects frequently spread bacterial wilt and mosaic disease. The larvae feed on the roots and underground portion of the stalks.

Cucumber beetles can be controlled with several insecticides, provided the material is applied as soon as the insects appear. If they are abundant when the plants come up, a delay of only 1 day may result in the loss of an entire planting. The most critical period is between the time the seedlings come through the ground and the time the plants begin to form vines. Growers should also be on the alert for first signs of injury to the fruits, which are especially subject to attack of the striped cucumber beetle.

Dusts or sprays containing rotenone, cryolite, or methoxychlor are recommended for use against cucumber beetles.

A dust should contain 1 percent of rotenone, 50 percent of cryolite (which contains 45 percent of sodium fluoaluminate), or 5 percent of methoxychlor. For spraying use one of the following in 100 gallons of water:

	Pounds
Derris or cube powder containing 4 percent of rotenone	4
Cryolite, wettable form containing 90 percent of sodium fluoaluminate	6
Methoxychlor, 50-percent wettable powder	3

Apply a light, even coating over the entire plant, especially where the stalk emerges from the soil. The beetles often congregate and feed at this point, causing serious injury to young plants. Apply dusts at 15 to 30 pounds per acre and sprays at 50 to 125 gallons per acre; suit the amount to the size of the plants and the type of equipment used. Repeat the application every week as long as the insects are present in injurious numbers. Dusts are most effective if applied when the air is calm and the plants are moist.

SQUASH BUG

The squash bug may damage pumpkin and squash throughout the United States. This insect feeds by sucking the sap from the leaves. The injured leaves wilt rapidly and become black and crisp. Small plants may be killed outright. In older plants some of the leaves or runners may be killed. In a severe infestation the production of fruits is lessened or prevented.

The adult bugs are dark brown, hard bodied, narrowly shield shaped, ⅝ inch long, and nearly ¼ inch wide; they have well-developed wings. They lay eggs on the undersides of the leaves. The eggs are shiny, oval, and yellow; they change to brown before they hatch. The newly hatched bugs, or nymphs, are green, soft bodied, and wingless. In later stages they turn gray and develop wing pads.

None of the insecticides now available are completely satisfactory for the control of the squash bug. Fairly effective results can be obtained, however, with sabadilla or nicotine. Use a dust containing 20 percent of sabadilla or 4 percent of nicotine. For sprays, use either 5 pounds of a 50-percent sabadilla wettable powder in 100 gallons of water or nicotine sulfate and soap in the dilutions recommended for the melon aphid (p. 9). Apply the dusts at 15 to 30 pounds per acre and sprays at 50 to 125 gallons per acre; suit the amount to the size of the plants. Treat both the upper and lower sides of the leaves. Also spray or dust the soil under and around the plants to kill the insects that fall while the plants are being treated. Start applications as soon as any eggs, nymphs, or adults of the squash bug are seen on the plants. Repeat once a week while the insects are numerous.

SQUASH VINE BORER

The squash vine borer may damage pumpkin and squash in areas east of the Rocky Mountains. When fully grown this insect is nearly an inch long and ¼ inch thick, and has a white, wrinkled body and a brown head. It enters the stem of the plant just above the soil surface and bores up the stem; it also bores into the vines, often causing the plants to wilt. Sometimes the vines are girdled or severed at their base. The fruits are occasionally attacked. As the borer becomes larger, the borings and excrement are pushed out of holes in the stems or vines and become very conspicuous. Badly infested plants often contain several of these borers.

Control of the squash vine borer is a difficult task, but fairly satisfactory results have been obtained with dusts or sprays containing rotenone or methoxychlor applied at the same strengths and dosages as for cucumber beetles (p. 12).

Apply these insecticides to the stems and vines near the base of the plant. Start when the runners develop and repeat at weekly intervals during the growing period.

The practice of covering the borer-damaged stems or vines with soil to induce rooting beyond the injured plant parts has long been followed, with success, especially on heavy soils in humid areas.

PICKLEWORM AND MELONWORM

The pickleworm and its close relative the melonworm are serious pests of squash during the summer and fall in the Gulf and South Atlantic States. The melonworm also infests pumpkin, but this crop is seldom infested by the pickleworm. These insects frequently cause considerable damage in States adjoining the Gulf and South Atlantic States and occasionally as far west as Kansas, Texas, Missouri, and Iowa, and as far north as the tier of States extending from Illinois to Connecticut. The insects feed on squash and other cucurbits throughout the winter in extreme southern Florida and similar subtropical areas and gradually spread northward each year. Except in southern portions of Florida and Texas, their injury to pumpkin and squash is most serious during the summer and fall months. Spring plantings escape damage in most areas in which the insects occur.

Young pickleworms are yellowish-white with numerous dark spots over the entire body; these spots disappear before the larvae are full grown. Young melonworms are greenish-yellow with two white lines that run the full length of the body; these lines remain until just before the larvae are full grown. Mature pickleworms and melonworms are about ¾ inch long.

The eggs of both insects are laid singly or in small clusters among the hairs on flower and leaf buds, small fruits, and young leaves. Young pickleworms feed on the surfaces where the eggs are laid, but soon tunnel into the flowers, terminal buds, stalks, vines, and fruits. Melonworms usually feed only on the foliage.

When pickleworms are present, it is not easy to prevent them from injuring squash. The larvae must be killed before they begin tunneling. In some areas, damage can be avoided by planting as early as possible in the spring. For late crops a satisfactory control program free of the hazard of poisonous residues and off-flavor has not been developed. Melonworms are much easier to control.

Lindane, when properly applied, will give good to excellent protection against the melonworm and pickleworm. It will also control cucumber beetles and aphids, and give partial control of the squash vine borer. A dust should contain 1 percent of lindane, and a spray 1 pound of 25-percent wettable powder per 100 gallons of water. *Use of lindane on some varieties of squash may give the fruits a slight off-flavor.*

Until additional information is obtained on the effects of lindane residues in the soil, *do not use lindane in fields to be planted later to potatoes or other root crops.*

A cryolite dust or spray will give fairly good control of the pickleworm and melonworm. A dust should contain at least 45 percent of sodium fluoaluminate, and a spray 8 pounds of 90-percent sodium fluoaluminate in 100 gallons of water. Unfortunately, applications of cryolite sometimes tend to increase melon aphid infestations. A dust containing either 1 percent of rotenone or 20 percent of sabadilla will give partial control.

The melonworm may be present within 2 weeks after seeding of late summer and fall plantings in the South, but the pickleworm usually does not appear until the earliest flowers open. Examine the terminal buds and the blossoms frequently and closely for presence of the small larvae. Begin applications of insecticide as soon as a pickleworm is found. Repeat weekly as long as the insect is present. It often occurs throughout the harvesting period.

Use 20 to 30 pounds of dust or 50 to 125 gallons of spray per acre; suit the amount to the size of the plants. For small plantings apply 2 to 3 ounces of dust or 2 to 3 quarts of spray to each 50 feet of a row that is approximately 6 feet wide. Dust only when the air is calm and the plants are moist.

Weekly use of the fungicide zineb for disease control will aid in the prevention of pickleworm and melonworm injury. The material is toxic to the newly hatched larvae.

DISEASES AND THEIR CONTROL

The diseases that most commonly affect pumpkin and squash are damping-off, downy mildew, powdery mildew, scab, bacterial wilt, fusarium root rot, black rot or gummy stem blight, fruit rots, and virus diseases.[3] Losses from disease often can be avoided or reduced by planting on clean soil, chemical treatment of the seed, and spraying or dusting the plants with fungicides.

Certain organic fungicides are referred to in this publication by recently coined common names. The common names and the chemical names are listed on the next page.

These chemicals are marketed under various trade names,[4] such

[3] Following are the scientific names of the fungi, bacteria, and viruses that cause the diseases discussed in this section:
Damping-off. *Rhizoctonia solani* Kuehn and certain species of *Pythium*.
Downy mildew. *Pseudoperonospora cubensis* (Berk. & Curtis).
Powdery mildew. *Erysiphe cichoracearum* DC.
Scab. *Cladosporium cucumerinum* Ell. & Arth.
Bacterial wilt. *Erwinia tracheiphila* (E. F. Sm.) Holland.
Fusarium root rot. *Fusarium solani* f. *cucurbitae* Snyder & Hansen.
Choanephora fruit rot. *Choanephora cucurbitarum* (Berk. & Rav.) Thaxt.
Black rot or gummy stem blight. *Mycosphaerella citrullina* (C. O. Sm.) Gross.
Miscellaneous fruit rots.
Erwinia carotovora (L. R. Jones) Holland.
Alternaria spp.
Rhizopus nigricans Ehr.
Fusarium roseum Lk.
Sclerotinia sclerotiorum (Lib.) DBy.
Botrytis cinerea Fr.
Cucumber mosaic virus. *Marmor cucumeris* Holmes.
Curly top virus. *Ruga verrucosans* Carsner & Bennett.

[4] Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guaranty or warranty of the product named and does not signify that this product is approved to the exclusion of other comparable products.

as Captan 50–W, Orthocide 50 (wettable), and Orthocide–75 Seed Protectant for products containing captan; Spergon for that containing chloranil; Phygon Seed Protectant for that containing dichlone; Fermate, Ferradow, Karbam Black, and Ferberk for those containing ferbam; Dithane D–14 and Liquid Parzate for those containing nabam; Arasan and Thiram–50 for those containing thiram; Dithane Z–78 and Parzate for those containing zineb; and Zerlate, Zirberk, and Karbam White for those containing ziram.

DAMPING-OFF

Damping-off of squash and pumpkin seedlings is caused by species of fungi that often are present in the soil. The most evident injury consists of a shriveling of the stem at the ground line, which causes the seedling to fall over and die. The fungi also may rot the seed or kill the seedling before it emerges from the soil. Damping-off is most common on very moist soil.

Losses from damping-off can be reduced by treating the seed with fungicides that protect the young seedlings before they emerge from the soil. Use thiram, chloranil, captan, or dichlone at the rate recommended by the manufacturer. Place seed and chemical dust in a tight container; put in no more than enough seed to half fill the container. Shake the container for 1 or 2 minutes. Screen off the excess dust.

DOWNY MILDEW

Downy mildew is a common and damaging disease of pumpkin, squash, and other cultivated cucurbit crops in the Atlantic and Gulf Coast States. The disease is not very important in other sections where these crops are grown.

Downy mildew is caused by a fungus, which usually appears after fruits have begun to set. The symptoms are numerous small, irregular, yellow spots on the leaves (fig. 8). These spots enlarge slightly and become dry in the centers.

Infection occurs most frequently on the older leaves; much of the older foliage may wither and die. The vine is so weakened that fruits are reduced in size and number. The disease does not attack the fruits directly.

The fungus spores are carried from one plant to another by air currents. They are not seedborne and do not live over in the soil. In Florida, however, the fungus lives

COMMON AND CHEMICAL NAMES OF CERTAIN FUNGICIDES

Captan	N-trichloromethylthio-tetrahydrophthalimide.
Chloranil	Tetrachloro-p-benzoquinone.
Dichlone	2, 3-dichloro-1, 4-naphthoquinone.
Ferbam	Ferric dimethyl dithiocarbamate.
Nabam	Disodium ethylene bisdithiocarbamate.
Thiram	Tetramethylthiuram disulfide.
Zineb	Zinc ethylene bisdithiocarbamate.
Ziram	Zinc dimethyl dithiocarbamate.

Figure 8.—Squash leaf showing the spotting characteristic of downy mildew.

throughout the year on some of its host plants. During the spring and summer the fungus is carried northward. Often the disease is present in the North Atlantic States in August.

The fungus is favored by cool, moist weather. It may also develop and spread rapidly in warm weather if there are frequent rains or heavy dews. Hot, dry weather tends to check the development of the fungus.

Once it appears in a field, downy mildew usually spreads rapidly unless plants are protected by a fungicide.

Downy mildew is not easily controlled. Losses can be reduced by efficient application of fungicides. Copper fungicides, used as sprays or dusts, are effective. The fixed copper fungicides are preferable to bordeaux mixture because they are less likely to injure the foliage. The organic fungicides, zineb, nabam, captan, and ziram, are effective also and are not likely to injure the foliage. Methods of preparing and applying the fungicides mentioned here are discussed on pages 26 and 27 under the heading "Spraying and Dusting."

POWDERY MILDEW

Powdery mildew affects squashes, pumpkins, muskmelons, and cucumbers. It has caused severe losses on squashes and muskmelons in sections of the Southwestern States. It is of less importance in other regions.

The disease is caused by a fungus that infects the leaves and stems of the plants. The first symptoms are small, white, superficial patches of fungus growth; these are most abundant on older leaves. The spots increase in size and number until the white powdery fungus growth may cover most of the leaf (fig. 9). Similar growth appears on portions of the stems and much of the older foliage may finally die. The disease is most severe in cool, moist weather. It causes little injury in hot, dry seasons. It is most prevalent toward the end of the growing season.

Sulfur dust is an effective fungicide for the control of powdery mildew but cannot be safely used on cucumbers and most varieties of muskmelons, particularly in hot weather. Squashes and pumpkins are more tolerant to sulfur, however, and sulfur dusts can be used to control the disease on these crops. Copper fungicides also are of some value in controlling powdery mildew. An organic fungicide sold under names such as Karathane WD and Mildex appears to be very effective for control of this disease.

Methods of applying the fungicides mentioned here are given on pages 26 and 27 under the heading "Spraying and Dusting."

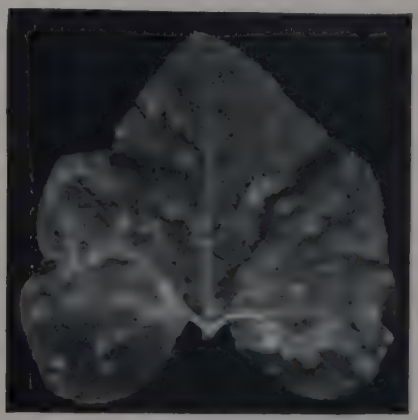

Figure 9.—Squash leaf showing white growth of the fungus that causes powdery mildew.

SCAB

Scab is caused by a fungus that affects squashes and cucumbers. It often damages summer squashes in the New England States and occurs along the Atlantic seaboard as far south as North Carolina.

The fungus attacks the leaves, fruits, and stems of summer squashes. On the leaves the first symptoms are very small water-soaked spots. These spots enlarge, show a yellow margin, and commonly become torn across. Stems show small, sunken, tan spots. Fruits are most susceptible when young but may be infected at any stage of growth. They first show small, slightly depressed, water-soaked spots that soon become more sunken and give the fruit a pitted appearance. In moist weather these spots are covered with a dark-gray or olive-brown growth of the fungus (fig. 10) and often show a clear or amber-colored gummy ooze. Fruits that appear sound when picked

sometimes develop the disease in transit because of infection just before harvest.

The scab fungus can overwinter on decaying plant tissue in the soil; most of the primary infection apparently comes from this source. There is a possibility, however, that seed occasionally may be contaminated by spores of the fungus. The disease usually appears in midseason and the fungus spreads rapidly when there are cool nights and heavy dews. Hot, dry weather checks the spread of the fungus.

Figure 10.—Squash fruit showing typical spotting by the scab fungus.

Crop rotation is very important in reducing losses from scab. Squashes, cucumbers, or related crops should not be grown on the same land oftener than once in 3 years. Seed treatment with bichloride of mercury (corrosive sublimate) as recommended for control of fusarium root rot (p. 20) will free the seed of possible contamination by spores of the scab fungus.

Although spraying has not proved effective in controlling scab on cucumbers, the use of fungicides helps control the disease on squashes. Spraying with commercial preparations of zineb or nabam (used with zinc sulfate) has been helpful in reducing losses from scab on summer squashes. Spraying should begin early in the season, and, where the disease occurs commonly, applications should be made every 5 to 7 days. Methods of applying the fungicides mentioned here are discussed on pages 26 and 27 under the heading "Spraying and Dusting."

BACTERIAL WILT

Bacterial wilt is a widespread disease of cucurbits that sometimes causes losses of squashes. Pumpkins are susceptible but seem to be less frequently damaged. Infection usually occurs in a single leaf, which shows a grayish-green patch that hangs limp in the heat of the day. Other leaves on the branch gradually wilt but remain green. Wilting eventually extends to other branches

and the plant finally withers and dies. When infected runners are cut across there is a dull-white, sticky slime that pulls out in fine threads if the finger is pressed against the stem and withdrawn. Squash fruits also are affected but may show no evidence of the disease until they have been stored for some time. The fruit symptoms are dark patches on the rind and decayed spots in the flesh; the patches and spots are filled with a slime such as is found in the stems.

Squashes show considerable varietal resistance to bacterial wilt and many varieties, such as Acorn, Butternut, Delicious, and Buttercup, rarely seem to be affected. Other varieties, such as Marblehead, Golden Delicious, and the Hubbard types, are more severely damaged.

The disease is caused by bacteria that gain entrance to the water-conducting vessels of the plant and apparently clog them. The bacteria are spread by the striped and spotted cucumber beetles (p. 12). The bacteria do not live in the seed or in the soil but are carried over winter in the bodies of the adult beetles.

Losses may be reduced to some extent by using insecticides to reduce the number of beetles in the field. This is especially important early in the season. In small plantings it may be helpful to remove and destroy wilted plants as they appear.

FUSARIUM ROOT ROT

The fungus that causes fusarium root rot attacks the outer tissues of the stem, causing the plant to wilt and collapse. It also causes a rot of the fruit. Both pumpkins and squashes are susceptible to this disease; summer squashes suffer most severely from it.

Early symptoms of the disease are a soft, mushy rot of the stem just above and below the soil surface. The infected area soon turns brown and the plant wilts rapidly. As the rot progresses the stem may be covered by a white or pinkish growth of the fungus. Wilting of large plants usually occurs in midseason but the fungus may infect plants of any age. Infected fruits develop soft, water-soaked areas that later become brown. As the infected areas dry, they have grayish-white, zoned markings. The rot may progress until the entire fruit is destroyed.

The fungus can penetrate the seed of infected fruits. Spores may lodge on the seed surface during seed harvest. It does not persist more than 2 to 3 years in the soil.

Crop rotation (growing cucurbits only once in 3 or 4 years) and seed treatment are the chief means of reducing losses from this disease. Spraying or dusting the plants with fungicides will not help.

If the seed has only a surface infestation of fungus, you can eliminate it by treating the seed with a 1–1,000 solution of bichloride of mercury (corrosive sublimate). Bichloride of mercury is available from druggists in the form of blue tablets or as a powder.

For each pound of seed make at least 1½ quarts of solution. Use bichloride of mercury blue tablets

for small quantities; 1 tablet dissolved in 1 pint of water makes 1 pint of a 1–1,000 solution. To make larger amounts dissolve 1 ounce of the powder in 7½ gallons of hot water; let the solution cool before you use it. Prepare all bichloride of mercury solutions in vessels of glass, earthenware, or wood; this chemical corrodes metal containers.

Pour seed to be treated into a loosely woven cloth bag until it is half full; then put it into the container of solution. Stir the seeds in the bag to make sure all the seeds get wet. Leave the bag in the solution exactly 10 minutes. Remove the bag of seed and rinse it for 15 minutes—in cold running water or in several changes of cold water. Take seeds out of the bag and spread them in a thin layer to dry.

Do not use the same solution for more than two lots of seed.

Bichloride of mercury is a deadly poison. For precautions, see page 27.

If the fungus is within the seed, soaking the seed in hot water (130° F.) for 10 minutes will eradicate the fungus. However, this hot water treatment seriously reduces the germination of the seed.

CHOANEPHORA FRUIT ROT OF SQUASH

This disease is caused by a soil-borne fungus that attacks the blossoms and young fruits of squash. If often causes serious loss in rainy seasons. The spores of the fungus are spread by air currents and by bees and other insects.

The blossom blight is characterized by a dense, white growth of the fungus that covers the blossoms after they have opened and begun to fade. Within a short time the fungus produces spore-bearing bodies and the growth becomes purplish black. When pistillate flowers are infected there also is a decay and death of the young fruits, which show the characteristic dark fungus growth (fig. 11).

Plants grown on well-drained land are likely to suffer less from choanephora rot than those on very moist soils. Crop rotation is advisable as a means of preventing serious losses. Spraying or dusting with copper fungicides, zineb, or ziram give some control of choanephora rot. Methods of applying the fungicides mentioned here are given on pages 26 and 27 under the heading "Spraying and Dusting."

Figure 11.—Squash fruit covered with a dark growth of the fungus that causes choanephora rot.

BLACK ROT OR GUMMY STEM BLIGHT

This disease is caused by a fungus that damages leaves, stems, and fruits of squashes and pumpkins. On the stems, the fungus causes an injury known as gummy stem blight; on fruit the decay is known as black rot. Black rot causes serious losses of squashes in storage; similar injuries occur on pumpkins. Susceptibility to black rot varies among varieties of squash. Fruits may be infected in the field but much of the infection occurs after harvest. Butternut squashes commonly show infection in the field, but the Hubbard types rarely show black rot until after harvest. Warm, moist weather favors the development and rapid spread of the fungus.

On seedlings there sometimes is a stem infection that girdles and kills the plants. Infected stems of older plants have water-soaked areas that become cracked, brown cankers from which there often is a gummy brown ooze. These cankers become covered with minute, black bodies (pycnidia) in which spores of the fungus are produced. Cankered branches commonly wilt later in the season. Infected leaves have irregular, brown spots that later are covered with the dark pycnidia.

On the fruits the infected spots first are dark and firm; later they become water-soaked and dotted with the tiny, dark fruiting bodies of the fungus (fig. 12). There may also be a gummy ooze from the decayed tissues. The rot sometimes extends through the flesh into the seed cavity; sometimes it spreads out only over the fruit surface.

The fungus lives over winter on the remains of diseased vines in the soil. Since it often reaches the seed cavity of infected fruits, it is possible that it is carried on the seed. In the field the stems are infected through growth cracks and injuries from insects. Stem-end decay often occurs in fruits growing on infected runners. After harvest the fruits are infected through wounds in the rind. The amount of decay in storage appears to be related to the amount of vine infection in the field.

Crop rotation is essential in reducing losses from black rot. Avoid growing cucurbit crops in the same place oftener than once in 3 years. Since the fungus may possibly be seedborne, it is advisable to treat the seed with bichloride of mercury as recommended for root rot (p. 20).

Spraying and dusting squashes or pumpkins for control of fruit rot diseases is not a general practice, but the application of fungicides in the field may reduce fruit rot in the field and in storage. The fixed copper fungicides, bordeaux mixture, ziram, ferbam, and zineb, all appear to have value for reducing losses from black rot. Methods of applying the fungicides mentioned here are discussed on pages 26 and 27 under the heading "Spraying and Dusting."

MISCELLANEOUS FRUIT ROTS

In addition to the fruit rots associated with bacterial wilt, root rot, choanephora rot, and black rot, there are other fruit rots of

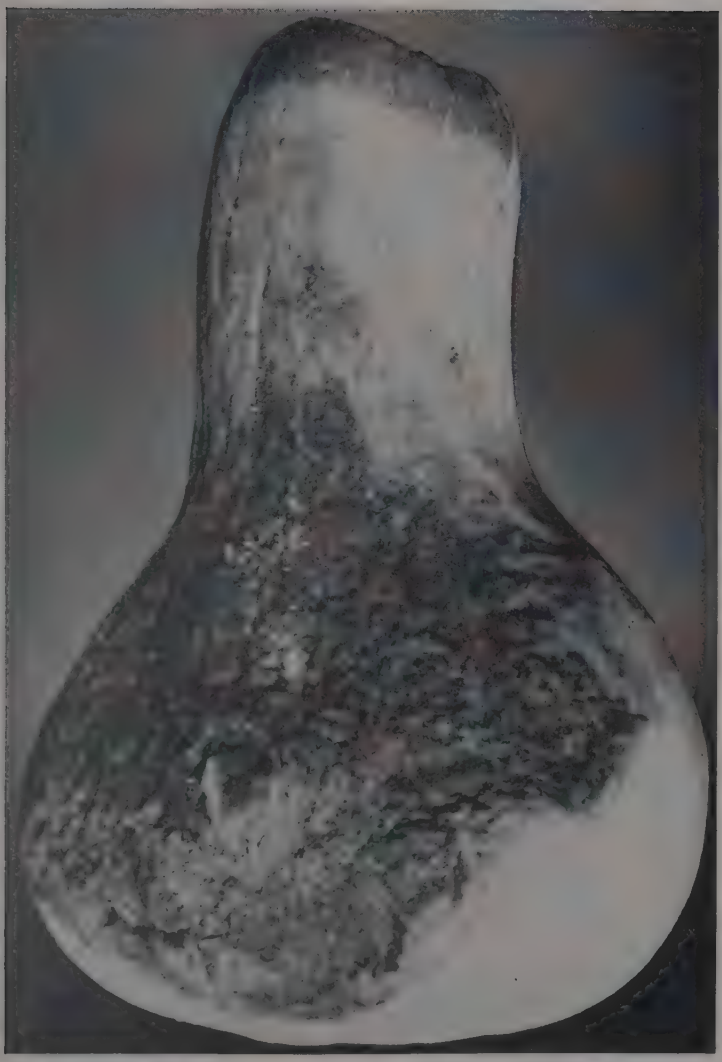

Figure 12.—Squash fruit showing symptoms of black rot. (Courtesy of the Massachusetts Agricultural Experiment Station.)

squashes and pumpkins caused by bacteria and fungi, some of which cause little or no injury to other parts of the plant. The symptoms on the fruit vary from a watery, soft decay to a dry rot of fairly firm texture. When caused by fungi, there usually is a growth of the causal organism on the surface of the rotted fruit and spores are produced that may infect other fruits in storage.

Most of these rots occur both in the field and in storage but are most common in storage. Infection of the fruits is favored by injuries to the surface in handling, by fluctuations of temperature, and by lack of heat and ventilation in storage houses that leads to sweating of the fruits.

MOSAIC

Mosaic is a widespread and often serious disease of squashes. Pumpkins are also susceptible to mosaic, but losses are less severe. More than one virus causes mosaic disease in squashes but the type of injury to the plants and methods of transmission of the viruses are generally similar.

If even a very small quantity of juice from a plant having a mosaic disease is brought in contact with a slight wound in a healthy plant, infection occurs. The mosaic viruses that affect squashes are spread most frequently by certain species of aphids; one of them is also spread frequently by cucumber beetles. These insects carry the virus when they feed on infected plants and then on healthy plants. Handling diseased plants then

Figure 13.—**Squash leaf showing mottling and deformity caused by the cucumber mosaic virus.**

healthy plants will also cause infection.

Squashes and pumpkins in the Central and Atlantic States are most commonly infected by the ordinary cucumber mosaic virus. Plants of the Yellow Straightneck type are particularly susceptible. The leaves produced after infection are mottled with yellow-green and there may be dark-green, blisterlike areas on the leaf. Such leaves often are misshapen and later growth is stunted (fig. 13). Fruits of Yellow Straightneck squash may be mottled with yellow and have an abnormally rough, pebbled surface. Pumpkin fruits also may show large, dark-green, raised spots on the surface. The yield of mosaic plants is reduced, and the fruits, even if not deformed, are likely to be small. This virus is not known to be carried in squash and pumpkin seed and does not live over winter in the soil. It is carried in the seed of the common wild cucumber, in the roots

of perennial weeds such as milkweed, wild ground cherry, and catnip, and in some perennial ornamentals. Aphids feeding on these plants can carry the virus to squash or pumpkin plants. The virus also affects cucumbers, muskmelons, pepper, celery, and spinach, and can be spread from these crops to squash or pumpkin.

Another virus disease known as squash mosaic causes serious losses on squashes and muskmelons in the Southwestern United States. The symptoms are similar to those of cucumber mosaic but the dwarfing and leaf deformity of the plants are more severe. The virus causing this disease is carried in a small percentage of the seeds taken from infected squash or muskmelon fruits. It also is transmitted in the seed of certain native wild plants of the cucurbit family. Certain species of aphids and of cucumber beetles are carriers of the virus, which also can be spread in handling of the vines.

The best ways to reduce losses from mosaic are to use mosaic-free seed, to control insects when practicable, and to destroy susceptible perennial weeds near the fields. These measures will not necessarily prevent the disease from appearing in the field, but they will frequently delay its appearance and prevent an outbreak early in the season.

CURLY TOP

The virus disease known as curly top limits culture of squash and pumpkin in many areas west of the Rocky Mountains. Where it occurs, the disease causes major losses also on beets, beans, tomatoes, and some other vegetable crops.

The curly top virus apparently is transmitted only by a single species of leafhopper that breeds in weedy, abandoned lands in semiarid regions west of the Rocky Mountains. The disease is most prevalent in the Intermountain and Pacific Coast regions but occasionally occurs in areas just east of the Rocky Mountains.

When squash and pumpkin seedlings are infected they soon die. Older plants are dwarfed, their runners are shortened and bent upward at the tips, and leaves are yellowed, blistered, and curled up at the edges. Because many blossoms fail to set fruit, infected plants are unproductive.

The virus lives over winter in wild host plants and can be carried over in the leafhopper. Leafhoppers overwinter and produce their spring broods on a number of perennial and winter-annual weeds, many of which are susceptible to the virus. When the spring broods of leafhoppers mature, many of them may migrate to cultivated areas and feed on susceptible crop plants. Many of the insects have acquired the virus from infected wild plants and transmit it to susceptible crop plants and weeds.

The severity of the loss from curly top depends on the size of the spring hopper movement, the percentage of the insects carrying the virus, and the time of the movement in relation to stage of crop plant development. Spring migration dates are influenced by temperature, and the direction of migration is determined by prevailing winds.

Aside from the use of resistant varieties there is no satisfactory way to control curly top on squash and pumpkin. Attempts to control the leafhopper in the crop field have not as yet been sufficiently effective to markedly reduce losses from the disease. With squashes, the best way to reduce losses is to use the tolerant varieties Umatilla Marblehead and Yakima Marblehead.

Spraying and Dusting

Losses from diseases such as downy mildew, powdery mildew, and a number of fruit rots may be somewhat reduced by the application of fungicides. Good results can be obtained only if spraying or dusting begins before disease is prevalent in the field and if the fungicide thoroughly covers the plants. Applications usually should begin when the vines blossom. Spraying is generally preferable to dusting but the extensive vine growth made by squashes and pumpkins may make dusting the more feasible method of applying fungicides by power equipment.

A spray or dust machine of the type commonly used on row crops can be used on squashes or pumpkins if the vines are trained in some rows to allow passage of the machine. The sprayer should deliver 150 to 200 gallons per acre at 300 pounds pressure and have 3 or 4 nozzles per row. Dusting machines should deliver a steady and uniform cloud of dust and 40 to 60 pounds should be applied per acre. Dusting should be done early in the morning or toward evening when the air is calm.

Fungicides should be applied at intervals of 7 to 10 days. When the weather is dry, a 10-day interval is not too long; during periods of high humidity and rainy weather, a 7-day or shorter interval is necessary.

Fixed Copper Sprays.—The fixed copper compounds include such preparations as basic copper sulfates, copper oxychlorides, copper oxychloride sulfate, and cuprous oxide. These compounds, sold under various trade names, can be used for control of leaf diseases and fruit rots of squashes and pumpkins. They cause less injury to the plants than is caused by bordeaux mixture.

These fixed copper preparations should be used in amounts that give 1½ pounds of copper (calculated as metallic copper) to 100 gallons of water. The copper content of each preparation is shown on the label and the amount needed can be calculated from this. For example, 3 pounds of a compound containing 50 percent of copper is needed to give 1½ pounds of copper in 100 gallons of water. With a compound containing 25 percent copper, 6 pounds would be needed.

Fixed Copper Dusts.—Fixed copper dusts usually can be bought from dealers in agricultural supplies. A dust containing 5 percent of actual copper can be used. These dusts are prepared by mixing a fixed copper compound with talc, pyrophyllite, or some other light, inert ingredient.

PRECAUTIONS

Chemicals used as fungicides are injurious to man or animals if taken internally; some are very poisonous. Use these chemicals carefully to keep them from getting into the mouth, eyes, or nose. Care must be taken to avoid inhaling chemicals used in dust form. When treating a large quantity of seed with a dust or dusting plants in the field, wear a respirator or dust mask. No mask is needed when small quantities of seed are treated in the open air or in a well-ventilated room.

Pour out the unused spray solution or mixture in such a way that it will sink into the ground and not stand in puddles. Clean thoroughly all vessels used in preparing a spray solution and plainly label all containers of chemicals. Keep the chemicals locked up, or, at least, out of reach of children.

The organic fungicides listed should not be used on pumpkins or squashes during the harvest season unless it is known that the residue will be removed by washing, wiping, brushing, peeling, or some other means. (Karathane WD and Mildex should not be applied within 7 days of harvest.)

Bordeaux Mixture.—Bordeaux mixture is a good fungicide but may be more injurious than fixed coppers to cucurbit crops, especially when the plants are small. Use a 6–6–100 mixture—6 pounds of copper sulfate (bluestone), 6 pounds of hydrated spray lime, and 100 gallons of water. In preparing such a mixture, use a finely powdered form of copper sulfate that dissolves quickly in water. Place the powdered copper sulfate on the screen of the spray tank and dissolve it by pouring enough water to fill two-thirds of the tank through the screen. Agitate the solution, add the lime in a thin paste, and wash in the lime with enough water to fill the tank.

Organic Fungicide Sprays.—For a spray containing zineb, ziram, ferbam, or captan, add 2 pounds of the commercial preparation to 100 gallons of water. When spraying with nabam, 2 quarts of the liquid fungicide is added to 100 gallons of water. To this is added 1 pound of zinc sulfate dissolved in water. Karathane WD and Mildex sprays are prepared by adding 6 ounces to ¾ pound of the fungicide to 100 gallons of water.

Organic Fungicide Dusts.—Zineb, ziram, ferbam, and captan can be prepared as dusts by adding 5 to 10 pounds of the fungicidal chemical to enough talc or other suitable carrier to make 100 pounds of dust. Such dusts are available from dealers in agricultural supplies. Karathane WD and Mildex are used as dusts containing ¾ to 1 percent of the fungicide.

ROOT KNOT[5]

Root knot is caused by minute eelworms, or nemotodes,[6] which attack the roots of squashes, pumpkins, and other plants in many parts of the country; it produces swellings, or galls, on the roots. Aboveground symptoms are lack of vigor, even dwarfing of the plants, and wilting during the hot period of the day. Root knot is often very serious in the sandy soils of the South. Whenever possible, pumpkin and squash growers should use land that is free of root-knot nematodes. As a measure for cleaning nematode-infested land to such an extent that it can produce pumpkins and squashes profitably, it is recommended that one or more of the following crops be grown on it 2 out of 3 or 3 out of 4 years in rotation with the pumpkin or squash: Small grains, hairy indigo, various crotalarias, and (in some localities) peanuts.

Root-knot nematodes can also be controlled successfully by fumigating the soil. The fumigants most commonly used are mixtures containing dichloropropene (such as D-D) and mixtures containing ethylene dibromide (such as Garden Dowfume and Dowfume W–85, Soilfume 85, Nemex, Bromofume 40, and Bromofume 85). Small quantities of a fumigant are injected into the soil at closely spaced points to a depth of about 6 inches, or a very small continuous stream of the fumigant is played along a furrow of that depth. A whole field may be fumigated, or the chemical may be applied only in rows or hills where seed is to be planted. For pumpkins, squashes, and other crops that are grown in widely spaced rows or hills, application in the row or in the hill has usually given satisfactory control of root knot at substantially less cost than treating the entire area. The benefits of soil fumigation last 1 year, seldom longer.

New soil fumigants may become available at any time. Improvements in methods, too, are apt to be developed. It is therefore recommended that up-to-date directions from the manufacturers be followed for details of application procedures.

The various general methods for fumigating soil may be classified as follows:

1. Entire-area fumigating, large-scale, is usually done with power-driven applicators that apply 6 to 10 parallel streams at the same time. Chisels or other devices deliver the fumigant into the soil.

2. Entire-area fumigating, small-scale, can be done with hand applicators; meticulous care is given to the spacing of the points of injection.

3. In-the-row fumigating, large-scale, is usually done with power applicators equipped to deliver a very small stream of the fumigant

[5] This section was prepared by Edna M. Buhrer, nematologist, Horticultural Crops Research Branch.

[6] *Meloidogyne* spp. (formerly *Heterodera marioni*).

in the row where seed is to be planted. A variation of this method, which delivers a very small stream on each side of the row, has been found more satisfactory in some cases.

4. In-the-row fumigating, small-scale, can be done with hand applicators. A single row of injections is made along each planting row.

5. In-the-hill fumigating is done with hand applicators. The position of each hill is determined and marked, and a single injection is made at each such point.

Soil is prepared for fumigation in the same manner as for seeding. The prepared soil should be moderately loose and reasonably free from clods, lumps, and undecomposed weeds or crop residues, and it should have a fairly smooth surface. Roots from the preceding crop should have had time to decay. The temperature of the soil should be 50° F. or above. The soil should be fairly moist at a level close to the surface; the fumigants do not give satisfactory results when applied to dry soil. In other words, the soil should be just moist enough to permit planted seed to germinate easily.

After a soil fumigant has been injected into the soil, holes or furrows left by the applicator should be filled promptly and firmly—merely knocking a little loose dry soil into them is not sufficient—and the soil surface should be left smooth and compact. If power equipment is used the soil surface can usually be smoothed satisfactorily with a drag attached behind the applicator. If it is necessary to drag or roll an area as a separate operation, this should be done promptly.

PRECAUTIONS

Anyone handling a soil fumigant should observe these precautions: Avoid prolonged breathing of the fumes. Never, under any circumstances, risk getting the liquid into the eyes or mouth. Do not allow the liquid to stay on the skin; wash it off promptly with soap and water. If the liquid is spilled on shoes, gloves, or other clothing, remove the garment without delay.

Let enough time elapse between applying the fumigant and planting the seed to allow the gases to escape, so seed will not be damaged. The length of time to allow varies with the fumigant used, the rate of application, and the moisture content and temperature of the soil. If fumigants are applied at the rates recommended by the manufacturer, the temperature of the soil is not below 70° F., and the moisture content of the soil is only moderate, the following intervals should be sufficient: For dichloropropene mixtures, 18 days; for ethylene dibromide mixtures, 10 to 14 days. The drier the soil and the higher its temperature, the quicker the gases escape. Fumigants linger in cool, wet soil.

Where in-the-row or in-the-hill fumigation is practiced, be careful to plant the seed *exactly* along each

treated row or near the center of each treated hill.

Several types of hand applicators are on the market. Large-scale operations requiring power-driven equipment often are carried out on a custom basis by individuals or companies engaging in the business of applying fumigants and owning the necessary equipment.

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